AN ESSAY
ON THE
NATURE and Superior USE
OF
GLOBES,
In conveying the
Firſt Principles of GEOGRAPHY and ASTRONOMY
To the Minds of Youth;
ALSO
A Candid Examination of the *Conſtruction* and
Uſe of PLANISPHERES,
WHEREIN
The *Erroneous Nature*, and many bad Conſequences, attending the Uſe of the *Vulgar Projection* are pointed out:
AND
The *Nature* and *Uſe* of the GLOBULAR PROJECTION,
With many NEW IMPROVEMENTS,
Illuſtrated by a Solution of Several PROBLEMS,
Explaining the general Principles of GEOGRAPHY and
ASTRONOMY, by Way of Introduction to the more
ready Uſe of the GLOBES.

This (Globular) Projection comes neareſt of all to the Nature of the Globe, becauſe the Meridians are therein at equal Diſtances, the Parallels alſo are nearly equidiſtant: I ſee no good Reaſon why our Geographers do not make uſe of it.

Dr. LONG in his Aſtronomy, page 155.

By *BENJAMIN MARTIN.*

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TO

The Ingenious and Ingenuous Part of the PUBLIC.

GENTLEMEN and LADIES,

I TAKE the Liberty of ſubmitting the following Tract to your Inſpection and Judgment; the Size is ſmall, but the Subject great and importing, and in which yourſelves are not a little concerned; when the Honour of Science is at Stake, every Member of your Community muſt be affected by it; and as you have the beſt and moſt impartial Judges among you, I chearfully appeal to them for the Equity of the Cauſe in which they will find me here engaged. I am the more inclined to do this as I am conſcious I have not been actuated by any other Motive than the PUBLIC GOOD; *this likewiſe has been the conſtant Inducement to all my other literary Undertakings. No Man has been more anxious to make the rugged Paths to Knowledge plain and eaſy; and the liberal Arts more generally acceſſible: When I have obſerved the heavy Lumber of Learning thrown upon you, I have endeavoured to render that Burthen eaſy and light: When Ignorance has attempted to caſt a Veil before your Eyes, and to darken Science by Words without Knowledge, with juſt Indignation I have endeavoured to take it away, and placed the fair Divinity, with all* *her native Charms, in the moſt amiable and advantageous Point of View. In ſhort, for twenty Years paſt my Views have been all directed to one End, viz. To make the Arts and Sciences as deſirable and intelligible to every Genius of your Community as I poſſibly could. And I have the great Satisfaction to find my Endeavours have been ſucceſsful, and honoured with your general Acceptance and Application. The manifold Inſtances of your Goodneſs and Generoſity demand my warmeſt Expreſſions of Gratitude; they have happily placed me beyond the reach of Envy and Detraction, and have entailed on me the everlaſting Honour of being male-treated by* DULNESS *and her* Votaries. *But while Providence preſerves my Health and Faculties, my leiſure Hours will ſtill be employed to promote and facilitate your Progreſs in the Studies of the Sciences and uſeful Arts, which will at the ſame Time afford the greateſt Pleaſure to Gentlemen and Ladies,*

Your moſt obedient humble Servant,

BENJAMIN MARTIN.

AN ESSAY ON THE Nature and Uſe of GLOBES, Compared with PLANISPHERES, MAPS, &c.

THE Miſapplication of the prime Part of our Time, I mean that which is ſpent in the Education of Youth, is a Matter of the moſt ſerious and intereſting kind; the Seed time of Life is our Youth, and the Harveſt of Humanity depends upon it. Whatever we ſow in our younger Days, we reap in our future adoleſcent State; and it is a well known Maxim with all Planters, that *as the Twig is bent, the Tree will grow.* In the Culture, therefore, and Plantation of human Life, the greateſt Care, Precaution, Prudence, and Art in this moſt important Species of Huſbandry, ſhould be uſed; for when the Harveſt proves not to our wiſhes, it muſt be imputed to the want of Providence, Induſtry, or Skill in the Huſbandman, whether he be the Parent or Tutor of Youth. The Soil, generally ſpeaking, is naturally good, and invites us to a chearful Cultivation; and the moſt barren is capable of great Improvement; we have nothing to charge on beneficent Nature, if the Trees of our own planting do not produce the Fruits we expect, the Blame falls not on the Tree, but ourſelves; for what reaſonable Man can expect *to gather Grapes from Thorns, or Figs from Thiſtles?*

As our Nurſeries of Youth are Schools of Education, they have always been thought of the greateſt Conſequence to the Dignity of the human Character, and the well-being of Mankind, and of courſe have been firſt in the Thoughts of all who have the Honour and Felicity of their Species at Heart. On this Account the moſt ample Inſtructions, Advice, and Aſſiſtance have been ſupplied in every Age for their Conduct and proſperous Succeſs: But as nothing arrives to Perfection at once, and nothing appears more gradual than the Progreſs of the Sciences, particularly thoſe of Geography and Navigation, it becomes conſtantly neceſſary to ſupply our Seminaries with the earlieſt Intelligence of the Improvements made in thoſe Sciences. Now the *true Figure of the Earth* being a modern Diſcovery, and as yet but very little known in our public Schools, and ſeveral learned Men have with great Reaſon ſhewn how far the Principles of Geography and Navigation are affected by it, and of courſe ought to be new modelled and regulated according to it, I have taken the Liberty to offer them my Service in that Reſpect, and have laid before them a genuine Account of this important Diſcovery; and ſupplied them with large and new Sea-Charts, and Tables of meridional Parts, for the Practice of Navigation, conſtructed on theſe new Principles; as alſo a large Specimen of a new and juſt Method of making Geographical Maps and coaſting Charts; and have good Reaſon to hope my Labour in this Affair will be acceptable to all thoſe who are pleaſed with the Advancement of Science, and endeavour the Improvement and Perfection of the Studies of Youth *. And indeed the greateſt Encouragement to this Undertaking has been the good Succeſs which has attended many of my former Eſſays, by the kind Reception they have met with from the Public.

My preſent Deſign regards thoſe young Gentlemen and Ladies who have a Taſte for *Geography*, and are willing to attain the firſt Principles thereof in the moſt natural and eaſy Manner. Now the firſt Steps that Art ſupplies for advancing in this Science are GLOBES, or their Projections *in Plano*, uſually called *Hemiſpheres*, *Planiſpheres*, or *Maps*, general or particular.

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* See my *New Principles* of GEOGRAPHY *and* NAVIGATION, juſt publiſhed.

It is no Wonder that the Science of *Geography* has always been held in the higheſt Regard, and looked upon as the moſt eſſential and polite Part of Education. For as nothing leſs is the Object thereof than the *terraqueous Globe* which Providence has aſſigned for the Habitation of the human Race, and the Scene of all their Actions, what can more deſerve their Notice and claim their firſt Regard and Knowledge than their native Earth? What can be more neceſſary than to look about them and ſurvey the various Scenery where they are deſtined to act their future Parts of Life? What more becoming a rational Being, than to know where he is, and how he ſtands related to and connected with others of his Species on different and diſtant Parts of the World? When we conſider the Magnitude, Figure, and Dimenſions of the Earth; the Diviſions thereof into Land and Water; the various Forms and Phænomena of each; the Diſtribution of Land into original Nations, Countries, and Kingdoms; and each Nation particularized by different Languages, Complections, Manners, Cuſtoms, Governments and Commerce; I ſay when all this and much more is conſidered, it muſt be looked upon as a ſtrange kind of Indolence and Supineneſs in a Man not to have the Curioſity of enquiring into and ſatisfying himſelf in regard to ſuch Notions, Characters, and Subjects as not only naturally give Pleaſure to the Mind, but are intimately related to our very Nature, Situation, and Fortune in Life; that diſtinguiſh Man from the prone and irrational Animal; that elevate and claſs us above the rude and unthinking Vulgar; and conſtitute that Part of Erudition, which above all others characterizes the *Gentleman* and the *Scholar*. But as the *Eulogium* of *Geography* has been oftentimes the Subject of abler Pens, and as it is a Science every one knows full well the Conveniency and Neceſſity of, I ſhall deſiſt from enlarging on this Head, and proceed to obſerve the beſt Method by which this uſeful Part of Knowledge may be inſtilled into the Minds of Youth; which I ſhall venture to affirm is by Means of the *Terreſtrial* and *Celeſtial Globes*, and I think that is evident beyond Diſpute, for the following Reaſons.

Firſt, The eſſential Property of a Globe, which is its *Figure* or *Form*, is that which alone would give it the Preference to all other Means or Methods for conveying the natural and genuine Ideas of Geographical Science to the Minds of Youth; they are firſt taught that the Earth we live upon is of a *round or ſpherical Figure*, and therefore it becomes neceſſary to facilitate that Idea, by preſenting to their View a Model of the Earth in Miniature, that is, a *real Globe*. To form a juſt Notion of a Thing, we muſt firſt frame to the Senſes the true Reſemblance of it, conſequently nothing leſs than an *artificial terreſtrial Globe* can give the Mind a true Conception of the form or Figure of the real *Globe of the Earth.* To talk of a *Globe in Plano* would be juſt as good Senſe and Logic, as to ſay there is *Light in Darkneſs*; for as Darkneſs is only the *Privation of Light*, ſo a Plane is only the *Privation of Sphericity or Convexity*; therefore no Projection *in Plano* can give any proper Idea of the very firſt Principle of this excellent Science. The ſame is true with regard to the *Heavens*, the Appearance of which is preciſely a *Spherical Figure*, and of Courſe can be repreſented only by the Convex Surface of a *Celeſtial Globe.* The Globe, therefore, in this fundamental Point, ſtands unrivalled by any Contrivance whatſoever.

Secondly, The next Principle in *Geography*, and the firſt in Aſtronomy, is the *Motion of the Earth upon its Axis:* This is a Matter of the higheſt Conſequence, as upon it depend the moſt conſiderable *Phænomena* of the viſible World; and it muſt be confeſſed that no human Invention but that of a *Globe* can any how repreſent this, or communicate an Idea thereof to the Mind which is adequately done by the Rotation of the *terreſtrial Globe* about its Axis; and the apparent Motion of the Heavens is as naturally and perfectly repreſented by that of the *Celeſtial*

leſtial Globe. In this Caſe, therefore, the Globes can have no Competitor.

Thirdly; As many *imaginary Circles*, great and ſmall, are neceſſarily required in the Science of Geography, for conveying cer and diſtinct Ideas of the Diviſions of the Earth's Surface, Situations of Places, Solutions of Problems, *&c.* Theſe can by no means be truly and naturally drawn but on the Surface of a real Globe: Here they have their proper Form and true Poſition, and real Interſections, ſuch as they have (or muſt be underſtood to have) on the Surface of the Globe of the Earth; but nothing of this Kind can be expected *in Plano*: For in projecting theſe Circles, their Forms and Poſitions are variouſly altered, and in many, their Nature quite changed, or a *Circle* becomes a *Right Line*. The Shifts, therefore, that we make with *Planiſpheres* are very imperfect and unnatural, and can give no correct Notions of this Science.

Fourthly; The Appearance of the ſeveral Parts of the Earth's Surface, both of Land and Water, is perfect and natural on the *Globe*; continuous and together as they ought to be ſeen, and repreſented to the tender Minds of Youth; but this is impoſſible in *Planiſpheres*, becauſe one half of the Globe muſt be disjoined and ſeparated from the other in the Projection, and thoſe Parts which are contiguous on the Globe and viewed in their natural Poſition, are here diſſevered and thrown at the Diſtance of the two Hemiſpheres from each other. An Imperfection that nothing but Neceſſity can tolerate or juſtify. And the Caſe is much worſe ſtill in regard to the ſtarry Firmament, which only the Surface of the *celeſtial Globe* ſhould be ſuffered to repreſent by the judicious Teacher of Geography.

Fifthly; The *true Form* and *Dimenſion* of Places can only be naturally and eaſily repreſented on the *Terreſtrial Globe*. For on the common Sort of Planiſpheres they are miſerably diſtorted and miſrepreſented indeed, as is well known to any Perſon but ever ſo little acquainted with the Nature of Projections. On the Globe every thing is ſhewn in juſt Proportion of Magnitude and Form; but on *Planiſpheres* nothing is ſo; but oftentimes the reverſe is obſerved: A ſmall Iſland or Country on one Part of the Map ſhall appear equal, or exceed one much larger than itſelf in another. Hence our Ideas are liable to be vitiated, which is the firſt Thing to be guarded againſt by the Tutors of Youth in all Sciences whatever, and more eſpecially in this.

Sixthly; The *Diſtance* and *Bearing* of Places is quite natural and eaſy to be obſerved and meaſured on the Terreſtrial Globe by means of the Quadrant of Altitude: They are here repreſented as they re-

ally are on the Globes of the Earth itſelf;
ut on Planiſpheres nothing of this Kind is
be expected; but on the contrary, equal
iſtances are there repreſented always, and
ery where unequal, and the whole is one
ſe Idea. On the Globe, the Diſtance, Po-
ion, or Bearing of any two Places are in-
antly ſeen, and known as they really are
themſelves. The Globe, therefore, can
nly give a true Idea of theſe geographical
rinciples to the Minds of Youth.

Seventhly; With reſpect to the mutual
oſition of the Globe of the Earth and its In-
bitants, nothing can repreſent that Mat-
r with any Degree of Eaſe, Truth, and
ropriety but the *Terreſtrial Globe* itſelf; the
levation of the Pole above the Horizon rec-
fies it inſtantly for the Inhabitants of a given
atitude; and it then exhibits a juſt Repre-
ntation of their own Situation on the Sur-
ce of the real Globe of the Earth rela-
ely to the Horizon, and the Heavens
out them. To attempt this in Planiſpheres
making a flat Piece of Work of it truly;
nd the Ideas accruing from thence to young
eople muſt be as aukward and imperfect as
e Operation itſelf; and therefore as far as
ſſible to be avoided.

Eighthly; The *General Meridian* and *Ho-*
zon of a Globe fit that Inrſtument for ex-
ibiting in the moſt natural and lively Man-
er the *Riſing*, *Culminating*, and *Setting* of

the *Sun*, *Moon*, *Planets*, and *Stars*, for ever Day of the Year; the *Length of Day an Night*, and the Diviſion of each into *Hour* by means of the *Horary Circle* and *Index* is ſo exact an Imitation of Nature itſelf, (no to ſay an Improvement of it,) that no on can rightly conſider it without Wonder; an muſt in vain expect any thing like it from Planiſpheres.

Ninthly; By means of the Celeſtial Globe the true Face of the Heavens for any give Day and Hour of the Night, or the viſible Hemiſphere of the Planets and Sta may be repreſented to the Eye in ſo ju and exact a Manner, that each Star in th Heavens may be ſeen to correſpond to i Repreſentative on the Globe; the Pole-Sta the Milky-Way, the Conſtellations, all ta lying in regard to thoſe Poſitions ſo nicel with thoſe in the Heavens as almoſt excee Expectation. But to attempt any thing o this kind in Planiſpheres would only argue a great Degree of Ignorance of the Nature and Uſe.

Eleventhly; If the *Terreſtrial Globe* b rectified and placed in the Sun-beams in proper Manner, which is very eaſy to b done, it will then duly repreſent the re Caſe of the Globe of the Earth with reſpect to the illumined and dark Part, an ſhew where it is Day and Night; the Seaſon of the Year will be naturally ſeen; which

Pol

ole is in the light, and which in the dark emiſphere. All which great Phænomena re, if not impoſſible, yet ſo very imperfect nd unfeaſible on Planiſpheres, that it is to no urpoſe to mention them on this Account.

Twelfthly; By a proper Apparatus the lobe may be ſo conſtructed, as not only to evolve on its Axis, but alſo that the *Poles f the World* ſhall revolve about the *Poles of he Ecliptic*, by which means the Phænomena f the Platonic Year, the ſlow apparent Motion of the Stars forwards; the Preceſſion f Equinoxes or Regreſs of the Equinoctial Points, the different Inclination of the Earth's Axis in different Ages of the World; the hifting of the Seaſons, and Feſtivals in Proceſs of Time through the whole Calendar, and many ſuch like important Particulars are dequately and properly accounted for; but which no intelligent Perſon would pretend o explain from Planiſpheres.

To the above-mentioned Advantages of Globes, we might add many others, *viz.* the natural Repreſentation of a *Ship's Way*, and all the *Caſes of ſailing*; an eaſy Illuſtration of the *Doctrine of Eclipſes*; the *Rationale* of *Dialling*; the *Phænomena* of the *Harveſt-Moon*; the *Solution* of all the Caſes of *Spherical Triangles* and aſtronomical Problems, &c. &c. &c. all which are naturally and properly ſhewn and ſolved on a Globe, but ſo unnaturally and ineffectually eſſayed on Planiſpheres, that I believe no ſkilful Profeſſor of thoſe Sciences will ever think it worth their Notice. One very material Advantage of Globes I had almoſt forgot to mention, *viz. That the Surface of a Globe is twice as large as the Surface of the Planiſpheres, into which it is projected, if the Diameters of each are the ſame*; or any Country is *twice as large* on a *Globe* of 18 Inches diameter, as on a *Map* or *Planiſphere* of the ſame Extent; and therefore a Map of 18 Inches anſwers but to a Globe of about 12 Inches in Point of Uſe or Accuracy.

Such, therefore, is the diſtinguiſhing Preheminence of Globes; this recommended them in every Age to the Admiration of the wiſeſt Part of Mankind, and induced them to recommend them in the ſtrongeſt Terms to the Study and Practice of others; and this will ever continue to be the Caſe. The intrinſic Worth and Value of any Invention will ſupport it, and *genuine Science* will continue as long as *Truth* and *Nature* have being.

As the whole DESIGN of GLOBES is to facilitate our Notions of geographical and aſtronomical Science; it is all we ought to expect; it is the Nature and Manner of the Thing to be communicated and repreſented, not the Degree of Accuracy with which it may be done, that is the Thing propoſed. If I am to exhibit to the Mind a clear, juſt, and natural Idea of the Form, Diviſion, and Magnitude of the Earth; the riſing, ſetting, *&c.* of the heavenly Bodies; the Nature of the Seaſons, Eclipſes, *&c.* I take the Globe; but if great Accuracy be required or the Quantity muſt be expreſſed in Minutes of *Motion* or *Time* it is another Affair; my Pupil muſt firſt be inſtructed in the Arts of Computation, and then referred to aſtronomical Tables to anſwer ſuch Deſign. If the Globe will ſhew him the Nature of an Eclipſe, it is enough; it would be ridiculous to expect from it, the true Time of its Beginning, Middle, or End: If it ſhews the riſing and ſetting of the Sun, in the moſt natural Manner poſſible, to Half or Quarter of a Degree or Hour of Time, 'tis as much as any reaſonable Man expects; and no Profeſſor of Geography who knows what he is about will pretend to more.

Diodorus Siculus tells us, the Invention and Uſe of *Globes* was firſt diſcovered by *Atlas*, King of *Libya* in ancient Times; others attribute the Invention to *Thales*, and that it was afterwards perfected by *Crates*, *Archimedes* and *Proclus*, but principally by *Ptolomy*; they were very uncouth in their primitive State, and even in the Time ſo late as *Gemma Friſius*, and *Gerardus Mercator*, as appears by thoſe publiſhed at *London*, *Anno* 1593, and by *Bleau*, the *French* King's Geographer, which are ſtill in being. And I judge it quite needleſs to ſay that Globes are now well known to have received their laſt Perfection in Point of Elegance and Beauty, as well as Correctneſs and Uſe by the peculiar Skill and Ingenuity of the late Mr. *John Senex*, F. R. S.

Thus much for GLOBES. Let us now turn our Thoughts on *Planiſpheres*, which tho' vaſtly inferior to Globes, yet are of ſome Uſe in the Study of Geography. For by Reaſon of their eaſy Conſtruction they come cheap, and may be purchaſed by almoſt any one, and eſpecially by many ingenious Perſons whoſe Fortunes will not command a Pair of Globes. 'Tis true they will not anſwer the Purpoſes of this Science in the beſt Manner, but ſtill they are better than nothing at all. Projections of the Sphere will ſerve as a general Introduction to the Uſes of the Globe, by preparing the Minds of Youth with ſome Notions of the *Circles* of the *Sphere*, Diviſions of the Earth into *Zones* and *Climates*; the *Latitude* and *Longitude* of Places; and the Solutions of many entertaining *geographical* and *aſtronomical* Problems, but in a Manner that is rather artificial than natural, however it will bring us as near the Truth as is neceſſary; and if the *Medal of Gold* be not in our Power, we muſt be content with its *Impreſſion*.

But with reſpect to Planiſpheres, there are different Kinds, as the Globe is projected on the Plane of the *Meridian*, *Horizon*, *Equator*, *Eclip-*

Ecliptic, *&c.* according to the Rules I have formerly given in my *Young Trigonometer's Guide*, Vol. II. The firſt of theſe, *viz*, that of the *Meridian* is of principal Uſe for geographical Purpoſes, and which at preſent we ſhall conſider and explain.

This Projection is either *Orthographical* or *Stereographical*. The *Orthographic Projection* is made by parallel Rays, or the Circles of the Sphere are referred to a Plane by the Eye at an infinite Diſtance; but as this Projection is uſeful only in *Aſtronomy*, and there principally in *Solar Eclipſes*, I ſhall ſay no more of it here.

The *Stereographic Projection* on the Plane of the Meridian is of two Forms; one reſulting from the Eye being ſuppoſed on the Surface of the Globe in the Pole of the primitive; and the other from the Poſition of the Eye at ſome Diſtance from the Globe in the Axis paſſing through the Poles of the primitive Circle or Meridian,

The firſt is the *Common Stereographic Projection*, on which all our *Maps* or *Planiſpheres* have been made from the Beginning; as the Contrivance is arbitrary, and without Reaſon, ſo the Conſtruction is unnatural and diſſimilar throughout; and conſequently the Uſes of it (in conveying the firſt Notions of Geography to the Minds of Youth) cannot but be looked upon as prepoſterous, fallacious and abſurd: For the *Meridians* as well as *Parallels* are here projected at unequal Diſtances in every Part, therefore the Repreſentations of the Land and Water muſt be very unjuſt, and their true Forms and Proportions utterly deſtroyed and loſt [*]. How it was poſſible for ſuch a vicious and diſtorted Conſtruction of Maps to maintain its Ground ſo long in the World is to me an unaccountable Thing. I have ever reflected on it as the greateſt *Opprobrium* to the Science of Geography, and have endeavoured all in my Power to expunge it, by placing another (more worthy the Regard of the Public) in the Room of it [‡]. Of which we ſhall treat by and by.

To give an Inſtance of the *Enormity* of this Projection, I need only obſerve that 5 Degrees on the outſide are equal to nearly 10 in the Middle, and conſequently the Surface of any Country is four Times as large in the firſt Caſe, as in the laſt.

But, as though the Projection was not bad enough in itſelf, it has been made ſtill worſe for the Uſe of *Engliſh Students*, by not making the *firſt Meridian* paſs through LONDON. This has been the general Fault of all the Map and Globe-Makers till lately. When a Map of the World is propoſed to

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[†] Theſe were my Sentiments of it twenty Years ago, when I gave the Rules of this Projection in Vol. II. of my *Young Trigonometer's* Guide, Page 55, 56.

[‡] See Vol. II. Page 482. of my *Philoſophia Britannica.*

made for any particular Nation, the *Firſt*
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y of that Country, to render it of eaſy
l general Uſe; no Man ſkilled in Geo-
phy will doubt of this Truth; nor will
but thoſe who have no Underſtanding
this Science chuſe a Map of the World
ſuch an unnatural and injudicious Con-
ction. As this vulgar Projection is ſo
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ne, but with little Succeſs, and in ſome
es the *Remedy has been worſe than the Diſ-*
. The Point aimed at has been to imi-
, or rather to mimic the *Rectification of*
bes for any Latitude indifferently; but for-
r Succeſs has ſhewn how little Merit there
n ſuch a Performance, and whatever may
expected from it, there is ſtill the leaſt
pes when it is applied to the common Ste-
raphic Projection, or *Vulgar Planiſphere.*
The firſt which I find endeavouring to
ify the Planiſphere (as it may be called)
any Latitude, was *Gemma Friſius*, in what
calls his *Aſtrolabium Catholicum*, but this
chiefly intended for aſtronomical Pur-
s. After him Mr. *Blagrave* publiſhed
Mathematical Jewel, in which he propoſes
o improve the Projection for geographical
es, by the Addition of what he calls the
et and *Label*, or the Lattice and Index;
t as he left it unfiniſhed, it was aſterwards

reaſſumed and compleated by Mr. *Palmer*,
the Year 1658, under the Title of the C
tholique Planiſphere, that is, in the mode
Stile, the UNIVERSAL PLANISPHERE.

This Improvement (as they called it) co
ſiſted in the additional Apparatus of verti
or *azimuth Circles* and the *Almicanterbs*
Parallels to the Horizon; theſe he direct
to be cut out of a Braſs Plate, and then a
plied it moveable on the Center, over t
Face of the ſubjacent Map, which he call
the *Mater*. On the ſame Center he al
adapted a Label or Index with Diviſions,
render the whole more compleat.

But the great Expence and Trouble join
with the natural Imperfection of the Inſtr
ment after all, induced Mr. *Palmer* to wi
for and think of ſome better Expedient f
this Purpoſe than his *Braſs Reet*. Accor
ingly, he directs it to be made of *Paſtboar*
in which the Circles may be cut out wi
Eaſe; or elſe of *clear Lanthorn Horn*, o
which the ſaid Circles might be drawn,
the Map be not too large; or laſtly, ſays h
“ If we had a *tranſparent Metal* much L
bour might have been ſaved.” It was im
poſſible for him here not to think of *Glaſ*
but either its Brittleneſs or the Difficulty
drawing the Circles, and applying it on
Center, diſcouraged him from mentioning
for this Purpoſe.

It was likewiſe highly improbable he ſhould
alſo think of an Oiled Paper, as its
e for Window-lights, Drawing, &c. was
y common; but ſince ſo judicious and
rned a Man is wholly ſilent upon that Ar-
e, we muſt conclude he had very good
aſon for it, convincing him it could by no
ans be fit for ſuch a Purpoſe.

However, his Book falling into the Hands of
ingenious Gentleman of my Acquaintance,
reſolved to give the Oiled Paper a fair
ial, and accordingly projected the Hemiſ-
re, and applied his *oleaginous Apparatus*
n it, but found his Labour was all in vain,
ugh his Curioſity was thoroughly ſatisfied
hout being at any *great Expence* for it.
is was done by him *ten Years ago*, and he
wed me his Performance, which he ſtill
by him.

By this ſhort Story the Reader will be
vinced there cannot be the leaſt Novelty
er in the *Title* or *Invention* of any mo-
n Performance of this Kind: What Me-
it may derive from the *Extreme Unction*,
y have the beſt Right to judge who have
ed the Experiment; from the Projection
lf it can pretend to none at all, as we
e ſhewn. We therefore take our Leave
this obſolete Piece of art, and proceed to
amine one of a different Kind; *viz.* that
ojection which approaches as near to the
ature and Form of a Globe as any thing

in Plano can do, and is deſervedly ſtiled the GLOBULAR PROJECTION, after which we ſhall ſpecify its Uſes, and illuſtrate the ſame in a Solution of a great Variety of entertaining Problems by it, and an Apparatus which I have added thereto.

In this *New Projection* the *Meridians* (which are the principal Circles of all) are *equidiſtant* from each other, as on the Surface of the Globe itſelf; the Parallels of Latitude are nearly ſo too, but the Poſition, Form, and Proportion of the ſeveral Parts of the Earth's Surface are very little affected by theſe, and conſequently a Map on the globular Projection is the beſt of all fitted for geographical Uſes, and indeed can be exceeded only by the Globe itſelf.

Dr. LONG in his Aſtronomy (Page 155) ſpeaking of this Projection, ſays, it was invented by Mr. *de la Hire*, and that it comes *the neareſt of all to the Nature of the Globe, becauſe the Meridians are therein ſet at equal Diſtances; the Parallels alſo are nearly equidiſtant*; the Doctor adds, *I ſee no good Reaſon why our Geographers do not make uſe of it.* I fancy if the Doctor had ſaid, *the Geographers had all the Reaſon in the World to make uſe of it*, no one would have thought he had in the leaſt exceeded the Truth.

Mr. *de la Caille* ſays, that according to M. *de la Hire*, the Diſtance of the Eye from the Plane of Projection is 1732 ſuch Parts as the Radius of the Table contains 1000; but according to M. *Parent* it is diſtant only 1595 of ſuch Parts. But neither of theſe Numbers will rightly aſſign the Diſtance of the Eye, as I ſhall demonſtrate in another Place. However, the Meridians and Parallels are all circular Arches, and drawn by the common Rules of Geometry. As this is the only RATIONAL and GENUINE PROJECTION of the *terraqueous Globe*, I think it well deſerves to be conſidered how far it is capable of being improved; at preſent I only propoſe to do it in the following Particulars; *viz.*

Firſt, The *General or* FIRST MERIDIAN paſſes through *London*, as it ought to do to make what relates to the Longitude of Places, conſidered either in Motion or Time, natural in itſelf and eaſy in Practice; eſpecially as this is an Article of the greateſt Importance, and neglected in common Planiſpheres or Maps.

Secondly; The MERIDIANS are drawn through every 15 Degrees of the Equator; and by this Means repreſent the Hour-lines moſt exactly; and the Intervals being divided in Halves and Quarters, it may be ſeen by a Glance of the Eye what the Difference of Time is between that of *London* and any other Place. For,

Thirdly; The HOURS for the Morning and Afternoon, are affixed to their reſpective Circles in each Hemiſphere at the Bottom, on the Parallel of 60 Degrees; and thus perform the common Uſe of an *Hour-Circle* and *Index*.

Fourthly; Between the Tropics is placed the Calendar, (as is uſual in the *Orthographic Projection*) for readily finding the Sun's Place in the Ecliptic; which Conveniency is not to be found in common Maps.

Fifthly; The Horizon of *London* is properly drawn, and divided into Degrees for the Amplitude and Azimuth of the heavenly Bodies; and the Points of the Compaſs for the Situation or Bearing of Places and the vertical Circles are drawn through the 8 Cardinal Points.

Sixthly; The Parallel of 18 Degrees is drawn below the Horizon, to ſhew at one View all that relates to the *Crepuſculum* or Twilight; its Beginning and End; when greateſt or leaſt; when there is, or is no dark Night, *&c.*

Seventhly; A QUADRANT OF ALTITUDE is added on the Side of each Hemiſphere from *London* to the Horizon, by which the Altitude of the Sun or Planets may be nearly eſtimated for any given Hour of the Day.

Eighthly; A SCALE *of Engliſh Statute Miles* is placed by each Hemiſphere that the Diſtance of any Place from *London* may be ſeen; it begins at *London* and extends to 7000 Miles.

Ninthly; By Means of the HOUR-CIRCLES

and HORIZON, the Different Length of Days and Nights; Riſing and Setting of the heavenly Bodies; the Viciſſitudes of the Seaſons, and other Things of this Kind, are rendered evident by Inſpection.

Tenthly; Theſe Hemiſpheres are adapted in Size to ſerve for *Hand* FIRE-SCREENS; in which Caſe a moveable Horizon is fitted upon the Handle, by which the Hemiſpheres may be rectified for any Latitude and ſo rendered of the moſt general Uſe.

Eleventhly; Theſe Hemiſpheres uſed as a Print or *Map of the World*, have moreover added (1.) The SOLAR SYSTEM of all the primary Planets, and ſome Comets. (2.) The Syſtem of JUPITER and his four Moons in due Portion of Diſtance. (3.) The Syſtem of SATURN, his five Moons, and Ring in their true Proportion of Magnitude and Diſtance. (4) A natural View of the Cauſe of *Solar and Lunar Eclipſes*, (5) A Diagram ſhewing the *Rationale of the Seaſons of the Year* by the oblique and parallel Poſition of the Earth's Axis in its annual Revolution about the Sun.

Twelfthly; The moderate Price as well as the Plainneſs and Simplicity of every Part will recommend it to all young Students in Geography as a *proper Introduction to the Uſe of the Globes*; as there is nothing here but what is natural and eaſy to be underſtood will occaſion no Fatigue to the Mind;

no Pain to the Eyes; nor offenſive *Emanations* to the moſt delicate Syſtem of *olfactory Nerves.*

The USE *of the* GLOBULAR PROJECTION.

GEOGRAPHICAL DEFINITIONS.

THE Terraqueous Globe conſiſts of *Land* and *Water*. The Land is divided into the following Parts, *viz.*

I. A *Continent* is a large Tract of Land including many Countries and Kingdoms not any where ſeparated by the Sea; theſe are four, *Europe*, *Aſia*, *Africa*, and *America*.

II. An *Iſthmus* is a narrow Neck of Land joining a Peninſula to the Continent.

III. A *Peninſula* is a Part of Land almoſt ſurrounded by Water, and joined to the Continent by an Iſthmus.

IV. An *Iſland* is a Part of the Globe that is entirely encompaſſed with Water, as *Britain*, *Madagaſcar*, *Borneo*, &c.

V. A *Promontory* is a Head or Cape of Land, which projects itſelf into the Sea, as the *Cape of Good Hope*, *Cape Horn*, the *Forelands*, &c.

VI. *Mountains*, higher Parts of Land well known.

The Waters of the Globe are divided into the following Parts, *viz.*

I. The *Ocean* is a vaſt Collection of Water that ſurrounds the Continents, Iſlands, *&c.*

II. The *Sea* is only a Part of the Ocean which lies between, and is nearly invironed with Land.

III. A *Gulph* is a ſmaller Collection of Water communicating with the main Ocean or Sea.

IV. A *Strait* or Channel is that narrow Paſſage by which Waters of the Sea run into the Gulph.

V. A *Bay* is a large and capacious Inlet of Water, proper for Ships to anchor in, as *Tor-Bay*, &c.

VI. A *Lake* is a deep Collection of Water quite encompaſſed with Land, as that of *Geneva*.

VII. A *River* is a perpetual Current of Water, proceeding from ſome Fountain or Lake to the Sea.

The MAGNITUDE *of the* EARTH.

THE Figure of the Earth is nearly that of a Globe; a great Circle of which being divided into 360 Degrees, and each Degree being found to be 69½ of *Engliſh* Miles, the Diameter of the Earth will be nearly 7964. The Circumference 25,020 Miles. The ſquare Miles in its Surface will be 199,250,205 very nearly; and the ſolid Content 264466,789,170 Cubic Miles.

Of the MOTIONS *of the* EARTH.

I. THE *Diurnal Motion* is that about its Axis in 24 Hours, Mean Time, which is at the Rate of 1042½ Miles in an Hour.

II. The *Annual Motion* about the Sun which is at the Rate of 1000 Miles *per* Minute.

III. Its Motion about the *common Center* of *Gravity* between the Earth and Moon.

IV. The Retrograde Motion of its Axis about the Poles of the Ecliptic, at the Rate of one Degree in 72 Years.

Of CLIMATES.

A *CLIMATE* is ſuch a Part of the Earth's Surface, contained between the two Parallels which makes one *half Hour's* Difference in the Length of a Day, of which there are 24 on each Side the Equator, to the Polar Circles. Between the Polar Circles and the Poles, there are reckoned ſix more Climates, wherein the Days increaſe by one *entire Month*. *N. B.* The Ancients allowed the Day to increaſe only $\frac{1}{4}$ of an Hour in a Climate.

Of LATITUDE *and* LONGITUDE.

I. *LAtitude* of a Place is the Diſtance thereof from the Equator, North or South, and eſtimated in the Degrees of the general Meridian. It is alſo equal to the Height of the Pole above the Horizon of the Place.

II. *Longitude* is the Diſtance of any Place, Eaſt or Weſt, reckoned in the Degrees of the Equator from the firſt Meridian, which in this Map paſſes through the City of *London*.

ASTRONOMICAL DEFINITIONS.

I. THE *Longitude* of the Sun or Star is the Diſtance from the Beginning of the Ecliptic or firſt Point of Aries, reckoned in Signs and Degrees of the Ecliptic.

II. The *Latitude* of a *Star* is its Diſtance from the Ecliptic, reckoned in a great Circle, paſſing through the Poles of the Ecliptic and the Star.

III. The *Declination* of the *Sun* or *Star* is its Diſtance from the Equinoctial Line, reckoned in Degrees of the Meridian.

IV. The *Equinoctial* is the ſame Circle in the Heavens as the *Equator* on the Earth; ſo called becauſe when the Sun is in it, it makes equal Day and Night.

V. *Right Aſcenſion* is that Point of the Equinoctial that comes to the Meridian with the Sun or Star.

VI. *Oblique Aſcenſion* is that Point of the Ecliptic that riſes with the Sun or Star.

VII. *Aſcenſional Difference* is the Number of Degrees between the Right and Oblique Aſcenſion.

VIII. The *Altitude* of the *Sun* or *Star* is its Height above the Horizon meaſured in Degrees.

IX. The *Quadrant of Altitude* is a thin Slip of Braſs the ¼ of a Circle, fixed to the general Meridian, over the Place, and moveable to any Part of the Surface of the Globe.

X. The *Azimuth* is the Angle contained between the Quadrant of Altitude and the Meridian, reckoned in Degrees of the Horizon.

XI. The *Amplitude* is an Arch of the Horizon between the Prime Vertical and Quadrant of Altitude, laid over the Sun or Star, it is either north or ſouth as the Sun or Star has north or ſouth Declination.

XII. The *Zenith* is the Point in the Heavens, exactly over the Place of the Spectator, as the Nadir is the Point juſt oppoſite to it, and on the Earth it is called the *Antipodes*.

The GREAT CIRCLES *of the* SPHERE, *on the* PROJECTION.

I. THE *Equator* Æ Q. divides the Globe into two equal Parts, and is divided into 360 equal Parts or *Degrees* of *Longitude*.

II. The *Meridian* Æ N Q S. is a Circle dividing the Globe into the Eaſtern and Weſtern Hemiſpheres, divided into 360 Parts or *Degrees* of *Latitude*.

III. The *Horizon* H O. is that great Circle which bounds our Sight or divides the

Globe into the viſible or inviſible Hemiſpheres.

IV. The *Ecliptic* E. C. is a great Circle, repreſenting the Path of the Sun divided into 12 Parts called Signs, and each Sign is divided into 30 Degrees. This Line croſſes the Equator in an Angle of 23 Degrees and a half.

V. *Azimuths.* Theſe are Circles which are drawn through the Place of the Spectator Z. to the oppoſite Point of the *Globe* D. of which that which paſſes through the Eaſt and Weſt Points of the *Horizon* is called the *Prime Vertical.*

The SMALL CIRCLES *of the* SPHERE.

The principal of theſe are the following.

I. THE *Tropic of Cancer* E. F. parallel to the *Equator*, and touching the *Ecliptic* in the firſt Point of *Cancer.*

II. The *Tropic of Capricorn* G. C. parallel to the *Equator* on the South Side, and touching the firſt Point of *Capricorn.*

III. The *Arctic Circle* a. b. a Parallel 23½ Degrees from the North Pole N.

IV. The *Antarctic Circle* c. d. at the ſame Diſtance from the South Pole of the World.

Of the POSITIONS *of the* SPHERE.

With reſpect to the Inhabitants of the Earth, the Sphere has three Poſitions. *viz.*

I. A *Right Sphere*, where all the Parallels are at right *Angles* to the *Horizon*, as under the *Equator*.

II. A *Parallel Sphere*, wherein the *Equator* becomes the *Horizon*; as to thoſe who live under the Poles.

III. An *Oblique Sphere*, wherein all the Parallels of *Latitude* are oblique to the *Horizon*.

Of the FIVE ZONES.

I. THAT Part of the Earth E. F. C. G. which lies between the two *Tropics* is called the *Torrid Zone*, becauſe the Inhabitants thereof have twice in the Year the Sun-beams perpendicular, and at all Times nearly ſo.

II. The *North Temperate Zone*, between the *Tropic* and the *Arctic Circle*.

III. The *South Temperate Zone*, between the *Tropic* and the *Antarctic Circle*.

IV. The *Two Frigid Zones*, within the *Arctic* and *Antarctic Circles*.

Geographical and *Aſtronomical* PROBLEMS ſolved.

On the GLOBULAR PROJECTION.

Problem I. *To find the* LATITUDE *of a* PLACE.

IN Order to this, let the Place be obſerved in the Map, and carry your Eye parallel to the *Equator*, towards the left Hand Side of the Map, if it be in the Eaſtern *Hemiſphere*, or towards the right Hand Side, if in the Weſtern, and you will obſerve the Degree upon the *Meridian*. Thus *Pekin* in *China* will be found in the Parallel of 40 Degrees in one, and *Cape Horn* about 57½ in the other.

Problem II. *To find the* LONGITUDE *of a* PLACE.

HAVING obſerved the Place in the *Map*, carry your Eye down from thence to the *Equator*, and you will eaſily ſee the Degree that correſponds to it. Thus the middle Part of *Madagaſcar* has 45 Degrees Eaſt *Longitude* from *London*, and *Jamaica* about 76½ of Weſt *Longitude*.

N. B. By this Method the Difference of *Latitude* and *Longitude* between any two Places becomes eaſily known.

Problem III. *To find the* PLACE *in the* MAP *from the* LATITUDE *and* LONGITUDE *given*.

ACcording as the *Longitude* is Eaſt or Weſt, you muſt look for the Place in the Eaſtern or Weſtern *Hemiſphere*.

Thus let the *Longitude* of the Iſland of *Ceylon* be 80 Degrees Eaſt of *London*, and 8 Degrees of North *Latitude*. Then caſt your Eye on the given Degree of *Longitude*, and riſing up to 8 Degrees of *Latitude*, you will there find the Iſle of *Ceylon*.

Problem IV. *To find the* DISTANCE *of any* PLACE *from* LONDON *in Engliſh* Miles.

IN the Eaſtern *Hemiſphere* on the Right-Hand of *London* above the *Meridian* is placed a Scale of 7000 *Engliſh* Miles. Then from any Place obſerved in the Map, you direct your Eye in a Parallel to the *Horizon* to that Scale of Miles, where you will ſee the Number expreſſing its Diſtance from *London*. Thus, *Pekin* will be found 5190 Miles from *London*.

Problem V. *To find how any* PLACE *bears from* LONDON.

THOSE that lie under the *Prime Verticle*, bear due Eaſt or Weſt; thoſe that bear North Eaſt and South Eaſt, or South Weſt and North Weſt will be ſeen under thoſe Circles in each *Hemiſphere*, and any other Place between being referred to the *Horizon*, the Point of the Compaſs will there be ſeen which ſhews its bearing from *London*, in either *Hemiſphere*.

Problem VI. *To find thoſe* PLACES *which have the ſame* LATITUDE *and* LONGITUDE *with the* GIVEN PLACE.

OBſerve the *Latitude* of the given Place and that Parallel of the *Equator* which paſſes through it, lies over all thoſe Places hat have the ſame *Latitude* in each *Hemiſphere*. And the *Meridian* paſſing through he given Place ſhews all the Places from Pole o Pole, which have the ſame *Longitude*.

Problem VII. *To find the* SUN'S PLACE *in the* ECLIPTIC *for any given Day in the Year.*

FIND the given Day in the Calendar by the Side of the Map, carry your Eye parallel to the *Equator*, till you meet vith the *Ecliptic*, and where that *Parallel* roſſes it will be the Place of the *Sun*. Thus or *May* the 8th, you will obſerve the *Paral-* *l* croſſes the *Ecliptic* in the 18th, Degree of *aurus*, which is the Sun's Place in the *cliptic* for the given Day.

roblem VIII. *To find the* SUN'S DECLINATION *for any* given Day.

OBſerve the Day of the Month in the Calendar on the Right-hand Side of the aſtern, or Left-hand Side of the Weſtern Hemiſphere, and by it in the Meridian is he Number of Degrees required. Thus, or Example, againſt the 8th of *May*, you ind 17½ Degrees for the *Sun's Declination*.

Problem IX. *To find the* SUN'S RIGHT ASCENSION *for any* given Day.

LET the given Day be the 8th of *May*, when the Sun's Place is in 18 Degree of *Taurus*, obſerve in the Equinoctial wha Degree is cut by the *Meridian* paſſing throug the Sun's Place, which in this Caſe will b found to be 45° 30', which ſhews the Di-tance in the Equinoctial from the firſt Poin of *Aries*, or the Beginning of the Equinoctial

Problem X. *To find the* SUN'S MERIDIA ALTITUDE *for any* Day required.

LET the Day propoſed be *May* the 8th when the Sun's Place is found to b in the 18th Degree of *Taurus*, through th Sun's Place, carry your Eye in a Parallel t the *Horizon*, and it will give you the Number of Degrees on the graduated *Meridia* on the Side of the Map, above the Horizo H O, and that will be the Altitude of th Sun for that Day at Noon, as required.

Problem XI. *To find the* AMPLITUDE *of th* SUN *at* RISING *or* SETTING.

LET it be required to find the *Amplitude* at Sun-ſet for the 8th Day of *Ma* obſerve the Parallel to the Equator whic

paſſet

paſſeth thro' the Sun's Place in the 18th Degree of *Taurus*; and where it interſects the Horizon will be the Amplitude required, which in the preſent Caſe will be in 27° 20′ from the Weſt towards the North.

Problem XII. *To find the Time of* Sun-Rising *or* Setting *on any given Day.*

LET the given Day be the 8th of *May*, the Amplitude of the Sun at Setting was found to be 27° 20′, obſerve what Meridian paſſes through that Point of the Horizon, and it will give the Hour of its Setting, which will be nearly half an Hour after VII. conſequently the Time of its Riſing will be half an Hour before V.

Problem XIII. *To find the* Beginning *and* End *of* Twilight *for any given Day.*

AT 18 Degrees below the Horizon in each Hemiſphere is drawn the Parallel P L. The *Twilight* begins when the Sun is ſet in the Horizon, and ends when it comes to the Parallel P L. The Meridian, therefore, which paſſes through that Point of the ſaid Parallel, will ſhew the Hour of the Night when the *Twilight* ends, which, in the preſent Caſe, will be nearly XI o'Clock.

Problem XIV. *To find the* AZIMUTH *of the* SUN *at any given Hour of the Day.*

LET the *Azimuth* be required for the 8th of *May* at 3 o'Clock in the Afternoon, make a Mark in the 3 o'Clock Meridian, where the Parallel of the Sun's Declination for that Day croſſes it; through that Point imagine an *Azimuth* Circle to paſs from the Zenith to the Horizon, and it will give the *Azimuth* from the South as required.

Problem XV. *To find the* ALTITUDE *of the* SUN *above the* Horizon *at any given Hour of the Day.*

LET the given Day and Hour be *May* 8th, at 3 in the Afternoon. Obſerve in the Weſt Hemiſphere where the Hour Circle of III interſects the Parallel of the Sun's Declination for that Day, from thence carry your Eye parallel to the Horizon, and on the Quadrant of *Altitude* by the Side of the Hemiſphere, you will obſerve the Height required, *viz.* about 38 Degrees.

Problem XVI. *To find thoſe* PLACES *to which the* SUN *is* VERTICAL *on any given Day.*

OBſerve in each Hemiſphere the Parallel of the Sun's Declination for that Day, for all the Places that lie under that

Parallel will have the Sun in the Zenith, and this will be twice in each Year at equal Diſtances from the Solſtice, in the North or South Parts of the Torrid Zone.

Problem XVII. *To find the* HOUR *at* LONDON *when it is* NOON *at any given Place.*

LET the given Place be *Madagaſcar*; the Meridian which paſſeth through that Iſland is 45 Degrees Eaſt from *London*, and every 15 Degrees being equal to an Hour, ſhews that when it is XII o'Clock there, it is IX o'Clock at *London*, as ſhewn in the Hour Circle in the Parallel of 60 Degrees in the lower Part of the Map, and ſo for any other Place.

Problem XVIII. *When it is* XII O'CLOCK *at* LONDON, *to find the Time at any other Place.*

LET the given Place be *Japan* in the Eaſtern Hemiſphere. The Meridian which paſſes through it is the 9th from *London*, which ſhews that it is then 9 o'Clock at Night in that Iſland.

In the Weſtern Hemiſphere the Meridian which paſſes by *Jamaica* is the 5th from *London*, which taken from 12, leaves VII for the Hour of the Morning there.

Problem XIX. *At any given* HOUR *of the Day at* LONDON, *to find all thoſe Places where it is then* NOON.

LET the given Hour be 9 o'Clock in the Morning; then obſerve what Parts of the Earth lie under the 9 o'Clock Hour Circle, for to all them it is at that Time NOON, as in *Madagaſcar*, *Arabia*, *Georgia*, *Muſcovy*, &c.

Problem XX. *For a given* DAY *and* HOUR, *to find the Place to which the* SUN *is then* VERTICAL.

LET the given Time be *May* 8th at 7 o'Clock in the Morning. Then having found the Sun's Parallel for that Day, obſerve where the Hour Circle of 7 croſſes it, which you will ſee is near the Coaſt of *Malabar*, Eaſtward of *Goa*. On the ſame Day the Sun is nearly vertical to *Jamaica*, a little after 5 in the Afternoon.

Problem XXI. *To find the* SPACE *of* TIME, *during which there is no* DARK NIGHT.

IT is evident by Inſpection in either Hemiſphere, that the Parallel of 20 Degrees North Declination of the Sun, juſt touches the Parallel P L of *Dark Night*, and therefore when the Sun's Declination exceeds 20 Degrees, there can be no *Dark Night*,

Night, and it is plain from the Calendar on the Side of the Map, that the Time will be from about the 22d of *May* to the 22d of *July* incluſive.

Problem XXII. *To find in the* NORTH FRIGID ZONE *all thoſe Places where the* SUN *begins to ſhine conſtantly without ſetting from the Equinox to the Summer Solſtice.*

OBſerve the Declination of the Sun for any given Day, then all thoſe Places which are the ſame Number of Degrees diſtant from the Pole, are thoſe required to be found.

Theſe are the principal Problems that are ſolvable by the Hemiſpheres for the Latitude of LONDON; and when they are made into HAND FIRE-SCREENS, an *artificial* or *moveable* HORIZON is adapted to them in the Handle, and then many of thoſe Problems are to be reſolved for any other Place as well as *London.*

The SOLAR SYSTEM.

IN the Print between the Hemiſpheres I have given the young Student a View of the SOLAR SYSTEM, with ſome of the cometary Orbits, that he might have ſome Idea of the *Number*, *Order*, and *Diſpoſition* of the PRIMARY PLANETS about the central SUN.

But as the Syſtem of the primary Planets muſt be very large to repreſent diſtinctly the proportional Magnitudes and Diſtances of the Planets from the Sun, we have here ſubjoined a Table for that Purpoſe, ſhewing the Diameter of each Planet in *Engliſh* Miles, alſo their Diſtances from the Sun in the ſame Meaſure; the Times of their Revolutions in Days, Hours, and Minutes, as here follow.

	Magnitudes	**Diſtances**	**Period. Times** D : H : ′
Mercury	2460	3200000	87 : 23 : 16
Venus	7906	5900000	224 : 16 : 49
The Earth	7960	8000000	365 : 6 : 9
Mars	4444	12300000	686 : 23 : 27
Jupiter	81000	42400000	4332 : 12 : 20
Saturn	68000	77700000	10759 : 6 : 36
Moon	2175	240000	27 : 7 : 43
Sun	822148	About its Axis	25 : 15 : 16

The JOVIAN SYSTEM.

IN the Right-Hand Corner of the Print at the Top, is repreſented the SYSTEM of JUPITER and his FOUR MOONS or *Satellites*, with their Orbits in their real Proportion of Diſtance from JUPITER's *Center*, meaſured in Diameters of his Body; which are expreſſed in Numbers, together with the Times of their Revolutions, as in the following Table.

The

The Times of Revolution of JUPITER'S Satellites.

	D	H	'
1	1	18	27
2	3	13	13
3	7	3	42
4	16	16	32

The SATURNIAN SYSTEM.

SATURN's Syſtem of 5 Moons, and wonderful *Ring*, is repreſented in the Left-hand Corner of the Print on the Top; and the Orbits of the Moons are drawn juſt in the ſame Proportion of Diſtance as in the Heavens they are found to have. The periodical Times in which they revolve about their Primary are as follow.

Satelites	D	H	'
1	1	21	18
2	2	17	41
3	4	12	25
4	15	22	41
5	79	7	16

Of SOLAR and LUNAR ECLIPSES.

WHAT relates to *Eclipſes* is ſhewn in a Diagram at the Left-hand Corner of the Print on the Bottom: The Eclipſe of the Sun is occaſioned by the Interpoſition of the new Moon between the Earth and the Sun; a ſmall Part of the *dark Shadow* falling on the Surface of the Earth *totally* eclipſes the Sun from thoſe Parts it paſſes over, which may extend to about 180 Miles. But there is a large *penumbral Shadow* (dotted in the Print) that covers a large Tract of about 9000 Miles, which cauſes only a *partial Eclipſe* of the Sun, which is greater or leſs as you are near to or farther from the *dark Shadow*.

On the other Side of the Earth's Orbit, the Full is repreſented as paſſing through the Shadow of the Earth, and of Courſe being eclipſed; as the Diameter of the Shadow is near three Times as large as that of the Moon, a *Lunar Eclipſe* if central, may ſometimes laſt four Hours. I have not repreſented the *penumbral Shadow* of the Earth, as it has but little Effect on the Moon.

Of the SEASONS *of the* YEAR.

IN the Right-hand Corner at the Bottom is a natural Repreſentation of the annual Motion of the Earth about the Sun, in ſuch Manner that its Axis is always inclined to the Plane of its Motion, and always kept parallel to itſelf. By this means it is neceſſary that in one Part of the Orbit the North Pole ſhould be turned towards the Sun, and the South Pole from it; and in the oppoſite Part of the Orbit the contrary happens. When the North Parts of the Earth are inclined towards the Sun we receive his Beams more directly, in a greater Quantity, through a leſs Part of the Atmoſphere, and in a longer Continuance above the Horizon; which Particulars together make this the hotteſt and moſt lightſome Seaſon of the Year, which we call SUMMER; for contrary Reaſons, in the oppoſite Part of the Orbit, it is WINTER with us. In the Parts between, the Seaſons are *temperate*, one of which is called the SPRING, and the other oppoſite to it AUTUMN. Not only the *Seaſons* but the *variable Length* of Days and Nights will be eaſily obſerved from the ſame Diagram, and may be pointed out to his Pupil by any intelligent Tutor.

F I N I S.

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